STUDIES IN THE XYLARIACEAE: IV.

HYPOXYLON, SECTIONS PAPILLATA AND ANNULATA.†

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INTRODUCTION

The genus *Hypoxylon* was established in 1791 by Bulliard, and because of its heterogenecity was reconstituted later by Fries in 1849. Unrelated species were excluded and others of close affinity introduced from the original polyglot genus *Sphaeria*. This and subsequent divisions into species groups were almost entirely based on stromal form. Nitschke (1867) and Saccardo (1882 *et seq*) relied primarily on the shape, size and degree of immersion of the stromata in the substrate. As further material was described however, it became evident that these characters could be influenced at least partly by environmental factors as well as by differences in hereditary constitution. Their correct assessment often became an intractable though fascinating problem.

Miller (1928) divided the genus according to the internal characters of the stroma. These included:

a) the quantity of stroma developed outside the perithecia;
b) the depth in the wood to which the stromata were sunken;
c) the colour of the stromal surface and that part immediately below;
d) the type of ostiole, whether papillate or umbilicate.

His classification, supplemented by the later one of 1961 was as follows:

Group I. Euhypoxylon. Stroma "woody" or corky in texture; ectostroma red or purple, entostroma dark. Ostioles umbilicate.
II. Papillata. Stroma "carbonaceous" or hard and rigid, coloured initially in one subsection; ostioles papillate.
III. Annulata. Stroma carbonaceous; ostioles papillate, each surrounded by an annular disc.
IV. Applanata. Stroma constantly effused, erumpent carbonaceous; ostioles usually papillate.

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In the writer's opinion Miller failed to give sufficient weight to the presence or absence of pigment in his classification. On this criterion Groups I and III and the pigmented species of Papillata would stand closer than the non-pigmented species of Papillata and Group IV. The latter have been placed by the writer respectively in a new section of *Hypoxylon*, Entoleuca, and in the genus *Numulariola*.

Miller describes coloured granules in a few of the pigmented species only, whereas in fact they are a recognizable feature in most of them, although they are not necessarily brilliant in hue and they may not be composed of the same substances. The writer has dissolved fragments of the ectostroma of *Hypoxylon fuscum*, *H. haematostroma*, *H. multiforme*, *H. rubrostromaticum* and *H. thouarsianum* in acetone, and used the filtered solution to make silica gel chromatograms. When examined under UV light none of the chromatograms showed any correlation with respect to the location and colour of fluorescent bands, although there was good correlation between subsequent chromatograms made from different samples of the same species. Neither was there any correlation between the species of *Hypoxylon* and two other species from different genera with coloured ectostroma, *Daldinia concentrica* and *Phylacia turbinata*. On the other hand no coloured pigment could be extracted from species of the section Entoleuca and the genus *Numulariola* exemplified by *H. serpens* and *N. signata*, and none also from *Xylaria poitei*, all of which have a rigid black outer layer of the entostroma and a superficial corky entostroma.

The other features linking the three pigmented groups and dividing them from Entoleuca are the constant position of the germ slit on the convex side of the ascopore and the plate-like shape of the ascal plug, which varies from extremely thin to discoid but is never longer than broad, the universal free-spreading germination pattern, the presence of stain, and absence of carbonaceous deposit in the culture medium. The traditional characters used to separate the groups are not always reliable: the ostioles of some species in the Papillata section may be quite indistinct while papillate ostioles have been seen occasionally in members of Euhypoxylon, and annulate ostioles have been observed sporadically in species of Papillata and in Entoleuca. Nevertheless they are satisfactory in a broad sense and certainly the groups should not be merged until the diverse pigments can be shown to be related in chemical structure.

In the writer's view the Papillata section as redefined (Martin 1967) forms a transition series between Entoleuca and Euhypoxylon. The ectostroma is initially soft and bright coloured, later merging with the entostroma beneath, and becoming hard and dark, but not sloughing off as in many species of Entoleuca (*H. mastoideum*). The entostroma may have a hard, rigid outer layer (*H. multiforme*, *H. cohaerens*) or be corky or brittle throughout as in some strains of *H. investiens*. Both the ectostroma and outer entostroma contain deposits of

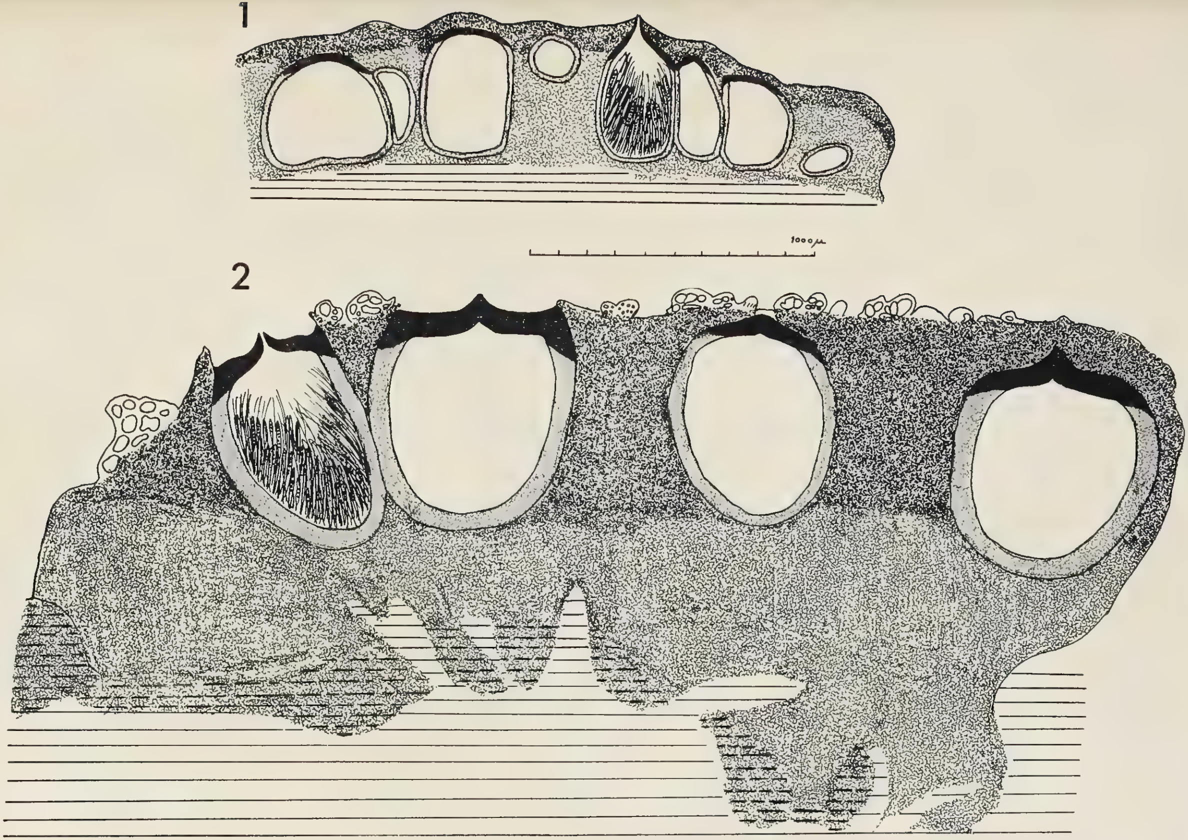

FIG. I. Vertical sections through Stromata. 1. *Hypoxylon investiens*. 2. *H. denudatum*. Note superficial (coloured) ectostromal granules. Key: Solid black: carbonous perithecial wall. Fine lines: remainder of perithecial wall, dark but less carbonous. Dark mottling: ectostroma and outer entostroma, with pigment and some carbonization. Light mottling: entostroma, basal tissue.

pigment that may appear refractive when the stroma is cut longitudinally. The basal tissue of the entostroma is corky and dark coloured, sometimes massive as in *H. multiforme.*

The Annulata section has basically similar stromata, but the degree of "carbonization" is greater in some species (*H. truncatum*, *H. thouarsianum*) and may extend well beneath the perithecial bases. The ectostroma sloughs away from the ostioles during development leaving circular indentations around them; thus the projecting part of the ostiole consists primarily of the perithecial wall which is dark and rigid. Elsewhere the ectostroma merges with the outer entostroma, sometimes leaving prominent superficial pigmented granules. (Fig. I : 2).

The Euhypoxylon section with some exceptions has softer stromata than in the other two groups, and the differentiation of the stromata varies with the colour and amount of pigment. The ostioles are umbilicate though sometimes raised from the stromal level, or merely indistinct.

Species in culture from these three groups have so far not yielded the *Nodulisporium* stage characteristic of Entoleuca. The Papillata section has the *Sporothrix* type of conidiophore, Annulata *Acrostaphylus*, while Euhypoxylon has both.

KEY TO THE SPECIES

1	Stroma corky; ectostroma dull or forming a brittle refractive glaze; pigment various, usually recognizable on sight; ostioles umbilicate, sometimes raised above stroma level..........(section Euhypoxylon).	
1′	Stroma sometimes corky but characteristically rigid; ectostroma dull or brittle refractive; pigment usually visible only in the developmental stage, but always evident through dissolving stroma in acetone or alcohol; ostioles papillate, sometimes indistinct	2
2	Ostioles simple papillate or infrequently annulate papillate, rarely umbilicate; pigment some shade of red or red brown in situ and in solution ....(section Papillata)	3
2′	Ostioles constantly annulate papillate; ectostromal pigment some shade of yellow, green or purple in situ and in solution..........(section Annulata)	6
3	Stromata small, pulvinate or turbinate, restricted in size though usually closely aggregated; perithecia immersed or vaguely evident. Surface initially purple brown, finally dull black; spores 4·0—6·0 × 9·0—12·0*μ *Hypoxylon cohaerens* Pers. ex Fr.	
3′	Stromata aplanate or aplanopulvinate, crustose, surface differently coloured	4
4	Initial stage of stroma yellow ochre, later brown to black. Perithecia usually sharply distinct in outline, globose, with conspicuous papillate ostioles. Spores 4·0—5·0 × 8·5—11·0μ *Hypoxylon multiforme* Fr.	

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*Figures expressed to the first place of decimals represent averages of several measurements to the nearest 0·5 μ; integers mere range of dimension.

4′	Stroma aplanate or aplanopulvinate, crustose, variable in extent, perithecia immersed or with evident vartices. Outer layer initially dull brown, orange brown or reddish brown, rarely purple brown, later black; perithecia evident in outline or immersed, with abruptly papillate or indistinct ostioles	5
5.	Spores 3·5—6·0 × 8·0—12·5μ *Hypoxylon investiens* (Schw.) Curt.	
5′	Spores 6·0 × 14·5μ *Hypoxylon rubigineo-areolatum* Rehm.	
6 (2)	Stromata with ostiolar discs less than 700μ in diameter..	8
6′	Stromata with extremely wide ostiolar discs, 700—1,000μ in diameter	7
7.	Spores 6—7 × 11—15μ, ave. 6·5 × 12·5μ *Hypoxylon bovei* Speg.	
7′	Spores 3—4 × 8—10μ *Hypoxylon bovei* var. *microspora* Miller.	
8 (6)	Perithecial discs flat to concave	10
8′	Perithecial discs convex; stromata aplanate	9
9.	Border of discs smooth or decussate; spores 5·5 × 11·5μ *Hypoxylon subannulatum* Henn. & Nym.	
9′	Border of discs abrupt, sharply defined; spores 4·5 × 9·5μ *Hypoxylon archeri* Berk.	
10.	Stromata predominantly aplanate or aplanopulvinate	11
10.	Stromata constantly subglobose to hemispheric	14
11.	Perithecia globose with prominent conical vertices; spores 4·5 × 12·5μ *Hypoxylon michelianum* C. & DN.	
11′	Perithecia oval to globose but with depressed vertices	12
12.	Spores pale brown subhyaline, 4·0—6·0 × 8·0—12·0μ; stroma conspicuously brick red to metallic purple at maturity *Hypoxylon denudatum* Petch.	
12′	Spores amber; surface coloration yellow, yellow-green or faintly purple, usually not persistent at maturity	13
13.	Spores 2—5 × 4—9μ, ave. 2·5—4·0 × 5·5—8·0μ *Hypoxylon stygium* (Lev.) Sacc.	
13′	Spores 3—6 × 6—12μ, ave. 3·5—4·5 × 8·0—10·0μ *Hypoxylon truncatum* (Schw. ex Fr.) Miller.	
13″	Spores 4—5 × 12—15μ *Hypoxylon truncatum* var. *pouceanum* (B. & C.) Miller.	
14 (10)	Perithecial discs prominently cupulate; spores 6—7 × 9—12μ *Hypoxylon hians* B. & C.	
14′	Perithecial discs often concave but not prominently cupulate	15
15.	Spores 4·5 × 8·5μ *Hypoxylon marginatum* (Schw.) Berk.	
15′	Spores 5·5—6·0 × 18·0—22·0μ *Hypoxylon thouarsianum* (Lev.) Lloyd.	

ANALYSIS OF SPECIES

I. Section Papillata.

A. *South African Species.*

1. **Hypoxylon investiens** (Schw.) Curtis. Plate I: 1–2, Fig. I: 1.

Berkeley, M. J. Journ. Linn. Soc. **10,** 385, (1869); Grevillea **4,** 52, (1875). Curtis, M. A., Geol. & Nat. Hist. Survey N.C. III, 140, (1867). Ellis, J. B. & B. M. Everhart, Journ. Mycol. **4,** 109, (1887); N. Amer. Pyren. 654, (1892) Miller, J. H., Monog Univ. Puerto Rico B **2,** 200, (1934); World Species of Hypoxylon, 52, (1961).

sub *Hypoxylon anthracoderma* Speg., Penzig O. & P. A. Saccardo, Malpighia II, 491, (1897). Spegazzini C., Anal. Soc. Cient. Arg. **26,** 30 (1888).

sub *Hypoxylon bakeri* Earle, Earle F. S., Bull Torrey Bot. Club **26,** 633, (1899).

sub *Hypoxylon berkeleyi* Sacc., Saccardo P. A., Sylloge Fungorum **9,** 551, (1891).

sub *Hypoxylon cohaerens* (Pers.) Fr. van *brasiliensis* Starb., Starback K., Bih. K. Svenska Vet. Akad. Handl. **27** (3), 8 (1901).

sub *Hypoxylon cupricolor* Petch, Petch T., Ann. Roy. Bot. Gard. Perad. **8,** 158, (1924).

sub *Hypoxylon discoideum* Ellis & Everhart, Ellis J. B. & B. M. Everhart, Proc. Acad. Nat. Sci. Philad III, **23,** 450, (1893).

sub *Hypoxylon epiphaeum* Berk. & Curt., Berkeley M. J. & M. A. Curtis, Grevillea **4,** 52, (1875).

sub *Hypoxylon glomeratum* Cke, Cooke, M. C., Grevillea II, 133, (1883). Miller, J. H., Bothalia **4,** 256, 1942.

sub *Hypoxylon gregale* (Schw.) Curtis, Curtis M. A., Geol. & Nat. Hist. Survey N.C. III, 140 (1867). Ellis, J. B. & B. M. Everhart, North American Pyrenomycetes 657, (1892). Miller J. H., Mycologia **20,** 320, (1928).

sub *Hypoxylon mascariensis* Berk. ex Cke. Cooke M. C., Grevillea II, 131, (1883).

sub *Hypoxylon merrilli* Syd. Sydow H. & P., Ann. Mycol. **15,** 212, (1917).

sub *Hypoxylon plumbeum* Speg. von Hohnel F., Denkschr. Akad. D. Wiss. Wien. Math. nat. Klasse **83,** 26, (1927). Spegazzini C., Anal Soc. Cient. Arg. **18,** 270, (1884).

sub *Hypoxylon rubigineo—areolatum* Rehm var. *bakeri* (Earle) Mill. Miller, J. H., Journ. Dept. Agric. Puerto Rico **14,** 273, (1930).

sub *Hypoxylon rubigineo—areolatum* Rehm var. *microspora* Theissen. Theissen F., Ann. Mycol. **6,** 345, (1908).

sub *Hypoxylon subvinosum* Speg. Spegazzini C., Anal. Soc. Cient. Arg. **18,** 269, (1884).

sub *Sphaeria gregalis* Schw. Fries E. M., Elenchus fungorum II, 68, (1828). Schweinitz, L., Trans. Amer. Phil. Soc. Philad. N S **4,** 193, (1832).

sub *Sphaeria investiens* Schw. Schweinitz L., Trans. Amer. Phil. Soc. Philad, N S **4,** 193, (1832).

Stromata aplanopulvinate or pulvinate, 1·1—22 × 2·0—76 × 0·5—1·5 mm., superficial on decorticated wood or bark, usually bright pink or orange brown when young but varying in colour through orange brown, rusty brown, dull brown, purple brown to black at maturity, samples often including a mixture of colours. Acetone extract of stroma deep russet brown. Surface smooth to very uneven or corrugated; ectostroma corky, entostroma hard though not carbonaceous, both dark coloured in longitudinal section. Perithecia varying from completely evident in outline to completely immersed, globose, normally adjacent but not close crowded, 250—900 × 300—900μ; ostioles papillate to inconspicuous, sometimes encircled by more or less distinct truncate discs. Asci cylindric, 80—170 × 4—8μ; stipes 22—96μ. Spores gibbous or navicular, ends narrow rounded, medium brown, variable in size, 3·0—7·5 × 6·0—18·0μ, ave. 4·7 × 10·3μ.

South African hosts: Acacia mollissima and wood unidentified.

Material examined:

sub *Hypoxylon effusum*, Rick; Brazil, (1905), (AA)*

sub *Hypoxylon epiphaeum*, Kauffmann; on Magnolia, Brooksville, Fla; U.S.A. (1918), (AA). Ellis 167; on *Magnolia glauca*, Newfield, N.J., U.S.A., (1894), (AA).

sub *Hypoxylon glomeratum*, Cain; New Durham, Ontario, Canada, (1931), (AA). Ellis 567; Kansas, U.S.A., (1884), (NYBG). Kauffmann; Ann Arbor, Mich., U.S.A., (1922), (AA). Kauffmann; Horseshoe Lake, Ann Arbor. Mich., (1925), (AA). (G.W.) Martin & Weldon 8363; Corundu, Panama Canal Zone, (1952), (NYBG). Seaver 952; St. Croix, West Indies, (1923), (NYBG).

sub *Hypoxylon investiens*, Martin 212; Hogsback, nr. Alice, E. Cape, South Africa, (1958). Martin 381, 1018; Nature's Valley, Knysna District, W. Cape, South Africa, (1958, 1962). Martin 389, 587; Alexandria Forest, E. Cape, South Africa, (1958, 1960). Martin 928, 929; Mazatlàn, Sinaloa, Mexico (1961). Martin 953, 959, 967, 971, 972, 975, 976, 979, 983, 995, 1529; San Blàs, Nayarit, Mexico, (1961, 1962). Martin 1,079, 1,082, 1,090, 1,091, 1,096, 1,100; Columbia, Mo., U.S.A. (1962). Martin 1,109, 1,122, 1,123, 1,152, 1,157; Lake Ozark, Mo., U.S.A., (1962). Martin 1,628, 1,629; Nyack, N.Y. State, U.S.A., (1963). Martin 1,647; Lake Sebago, Rockland Co., N.Y. State, U.S.A., (1963). Martin 1,765; ex Carroll 118, Vulcan Irazu, Costa Rica, (1962). Shear; Longwood, Fla., U.S.A., (NFC). Ziller 3,562; on *Alnus rubra*, Cooke, B.C., Canada, (FBLBC)..

sub *Hypoxylon rubigineo—areolatum*, Rick; Brazil, (1902), (AA).

sub *Hypoxylon rubiginosum*, Kauffmann; Brooksville, Fla. U.S.A., (1919), (AA).

sub *Hypoxylon serpens*, Dingley on *Fuchsia excorticata;* Wairekii, Auckland, New Zealand, (1953), (CMI).

sub *Hypoxylon vinoso—purpureum*, Langlois in Ellis herb. (ined.): La., U.S.A., (NYBG).

Cultural Characters: (Plate III: 1—4, Plate IV: 1):

Colonies canescent to velvet-felty, sometimes appressed, usually with a fine texture and rather dense, uniform, dull white. Margin entire, with peripheral hyphae lying together. Stain absent or ochraceous and diffuse, darkening with

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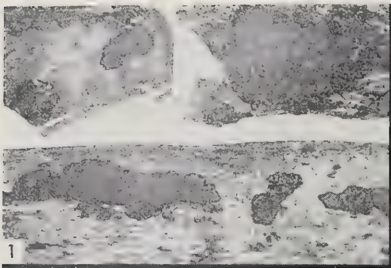
*See Martin (1968) for list of abbreviations of herbaria.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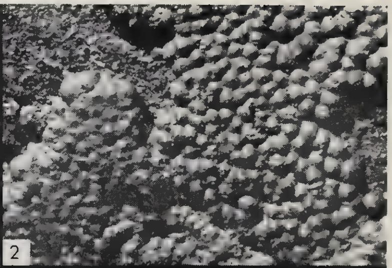
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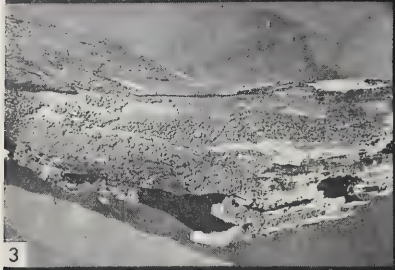
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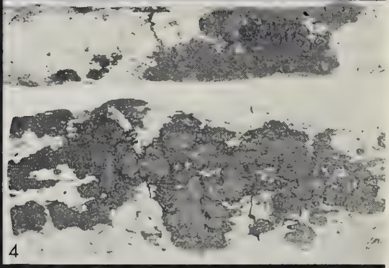
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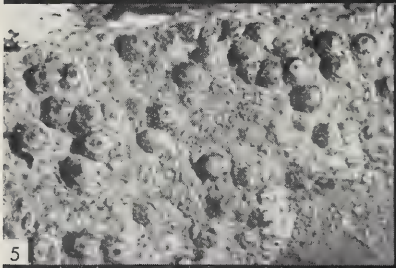
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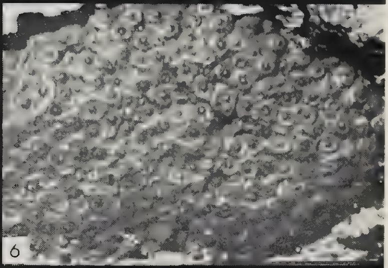
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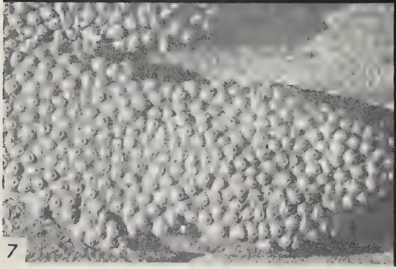
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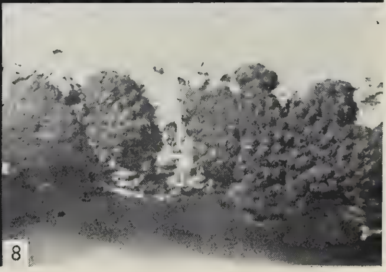
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age to dull brown. Conidial production variable, occurring after 7 days or as much as a month, giving the colony a granular appearance. Growth at 25°C moderate to fast, 3·2—6·5 mm./day.

Microscopic Characters: (Fig. III: 1–2):

Primary mycelium not diagnostic; maximum diameter of the marginal hyphae = 2·3μ. Secondary mycelium present or absent, if present then ropy or loosely organised, comprising long, frequently septate hyphae 1·5—4·0μ diam. occurring at the centre of the colony.

Conidiophores and conidia (Fig. III: 3–5):

The occurrence of coremia has not been previously reported for this species but was observed in one strain in culture, where small aggregations of mycelia developed all over the surface of the colony. These measured 0·2—0·3 × 0·4—0·6 mm. and were unbranched, straight, clavate, fertile over the apices and sides, and white in colour. In the other strains the conidiophores were hyphomycetous. In all strains the conidiophores form part of an indefinitely branched system, each conidiophore 75—600μ long, dichotomously branched to the second degree or indefinitely, axes 1·5—2·9μ; ultimate fertile branches 11—95 × 1·0—2·5μ, smooth with the apices often swollen, entire or sometimes partite forming distinct knobs. The conidia are acrogenous or borne in groups off the sides of the hyphae. The youngest conidium is always in the centre of a fully formed apical cluster. Usually the fertile hypha elongates beyond the site of the first formed conidia so that they later appear to have arisen in fascicles. The conidia are oval or oval-elliptic, sessile and clavate with narrow truncate bases or suspended by sterigmata and pyriform; yellow, pink or dull brown collectively, and extremely variable in size from one strain to another, 1·4—3·4 × 2·0—7·4μ, ave. 2·5 × 4·1μ.

2. **Hypoxylon rubigineo—areolatum** Rehm.

Miller J. H., World species of *Hypoxylon* 52, 1961. Rick J., Broteria Bot. ser. **25,** 28, 1931. Theissen F., Ann. Mycol. **7,** 146, 1909.

sub *Hypoxylon semi—truncatum* Miller. Miller, J. H., Monogr. Univ. Puerto Rico ser. B **2,** 205, 1934.

PLATE I. Stromata. (Magnification: 1, 3 & 4 × 0·4. 2,5–8 × 3·5).

Hypoxylon investiens. 1. General view of stromata. 2. Close-up.

H. truncatum. 3. Uni- and multiperitheciate stromata on decorticated wood (*Olea capensis*). 4. Extensive carbonization of bark (*Olea capensis*). 5. Close-up of young stroma with perithecia developing singly; also showing rupture of ectostroma above them.

6. *H. truncatum*
7. *H. stygium* } mature stromata with annulate ostioles.
8. *H. denudatum*

Stromata aplanate, forming thin crusts 3—13 × 5—50 × 0·5—1·0 mms. high. Surface of ectrostroma brown, sometimes brown with traces of purple, turning black with age; interior dark brown, rather hard, without any apparent differentiation. Acetone extract deep brown. Perithecia evident at least partly in outline or completely immersed, globose, sometimes with conic vertices, 200—600 × 500—700μ; ostioles minutely papillate, indistinct, or occasionally umbilicate or truncate papillate. Asci cylindric or clavate, 130—170 × 10μ; stipes 45—80μ. Spores oval-elliptic, equilateral, light amber brown, 45—90 × 9·0—16·5μ, ave. 5·6 × 12·9μ. This species is doubtfully separable from *H. investiens* on account of its spore characters and tropical distribution.

South African hosts: *Olea capensis,* decorticated wood and bark.

Material examined:

sub *Hypoxylon atropurpureum.* von Hohnel: on *Fagus*, Jaize, Bosnia, (1901), (AA). Holway sub Ellis 1,180; on *Tilia americana*, Decorah, Iowa, U.S.A. (1882), (AA). Wehmeyer; on *Tilia americana*, Ann. Arbor, Mich. U.S.A. (1924), (AA).

sub *Hypoxylon latissimum.* Costa & Castro 873; Pincorama, Brazil, (1935), (NYBG).

sub *Hypoxylon rubigineo—areolatum.* Martin 379; Nature's Valley, Knysna District, W. Cape, South Africa, (1958). Rick 306; San Leopoldo, Brazil, (1907), (NYBG).

Cultural Characters: (Plate III: 5—6):

Colonies dense velvety with fine texture, pure intense white. Margin not distinct, marginal hyphae lying parallel. Conidia develop by 8—14 days, turning the surface granulate pink. Stain absent or faint amber brown. Growth exceedingly slow on malt, 0·1 mm. per day, somewhat faster on maize agar. More cultures are required for study before this can be said to be a specific characteristic.

Microscopic Characters:

Primary mycelium undiagnostic; maximum diameter of the marginal hyphae =2·3μ.

Conidiophores and conidia (Fig. III: 6):

Coremia not observed in nature or in vitro. Conidiophores not distinct from the vegetative mycelium, forming branching systems 130—180μ long, simple or dichotomously or rarely ternately branched to the second degree, axes 1·6—2·0μ; fertile branches 19—130 × 1·2—1·5μ. Conidia acrogenous or in groups off the sides of the hyphae, borne on slender stigmata, elliptic to pyriform with the basal end tapering to a point, pale pink collectively, 1·1—2·6 × 4·6—9·7μ, ave. 2·0 × 5·8μ.

B. *Foreign Species.*

3. **Hypoxylon cohaerens** Pers ex Fr. (See Martin (1967) Plate IV: 5).
Berkeley M. J. in Smith J. E., English flora **5,** (2), 237, (1836); Grevillea **4,** 49, (1875). Bizzozero G., Flora Ven. critt. **1,** 200, (1885). Bresadola G. & P. A. Saccardo., Malpighia **13,** 442, (1889). Chardon C. E., Bol. Real. Soc. Espana Hist. Nat. **28,** 120, (1928). Cooke, M. C., Handbook of British Fungi, **2,** 795, (1871); Handbook of Australian fungi 294, (1892). Currey F., Trans. Linn Soc. Lond. **22,** 266, (1859). Dennis R. W. G., British Cup fungi 177, (1960). De Notaris G., Sferiacei Italici 15, (1863). Ellis J. B. & B. M. Everhart, Journ. Mycol. **4,** 43, (1888); North Amer. Pyren. 635, (1892). Fries E. M., Summa Veg. Scand. 384, (1849). Fuckel L., Symbolae Mycologicae 234, (1869—1870). Junghuhn F. H., Praemissa Fl. Crypt. Javae 19, (1838). Lambotte E., Flore myc. belge 422, (1880). Lloyd C. J., Myc. Writ. 7, 1352, (1925). Miller J. H., Trans Brit. Mycol. Soc. **15,** 138, (1930); World Species of *Hypoxylon* 46, (1961). Nitschke T., Pyr. Germ. **1,** 42, (1867). Quélet, L., Champ. Jura & Vosges **3,** 491, (1875). Rabenhorst G. L., Deutsch. Krypt Flor. **I,** 221, (1844); Krypt Flor. Deutschl. **II,** 858, (1887). Saccardo P. A., Fungi Ital. 570, (1877—1886). Schroter J. in Cohn: Kryptflor Schlesien 460, (1908). Shear C. L., Mycologia **20,** 84, 1928. Starback K., Bih. Svenska. vet. akad. Handl. **27,** (9), 8, (1901). Theissen F., Ann. Mycol. **8,** 453, (1910). Traverso J. B., Flor. Ital. Crypt. **1,** 48, (1906).

sub *Hypoxylon atrorufum* E. &. E. Ellis J. B. & B. M. Everhart, North Amer. Pyren. 742, (1892). Shear C. L., Lloydia **8,** 260, (1945).

sub *Hypoxylon bagnisii* Sacc. Saccardo P. A., Michelia **1,** 24, (1877). Traverso J. B., Flor. Ital. Crypt.**1,** 48, (1906).

sub *Hypoxylon turbinatulum* (Schw.) Berk. Berkeley M. J., Grevillea **4,** 51, (1875). Ellis, J. B. & B. M. Everhart, Journ. Mycol. **4,** 43, (1888); N. Amer. Pyren. 636, (1892). Owens C. E., Proc. Indiana Acad. Sci. **1911,** 308, (1912).

sub *Sphaeria cohaerens* Pers. Albertini J. D. & L. D. de Schweinitz, Consp. Fung. Lusatiae 4, (1805). Fries E. M., Systema Myc. 333, (1823); Elenchus Fung, **2,** 63, (1828). Persoon C. H., Syn. Meth. Fung. 11 (1801—1808).

sub *Sphaeria turbinatula* Schw. Schweinitz L. D., Trans. Amer. Phil. Soc. Philad. N.S. **4,** 192, (1832).

Stromata glomeruliform to pulvinate or aplanopulvinate, usually aggregated and merging into one another, 1·5—4·0 × 1·5—21 × 1·2—3·5 mms., usually erumpent and becoming superficial by attrition of the substrate. Surface somewhat flattened, smooth, initially light brown then dull brown to purple brown or pale purple, becoming purple-black with age. Acetone extract purple brown. Exterior hard, semi-carbonaceous, without apparent differentiation. Perithecia evident at the vertices to completely immersed, oval, longer than broad, 400—

600 × 600—900μ; ostioles medium papillate to minutely papillate or indistinct, occasionally umbilicate. Asci cylindric, 110—135 × 4—5μ; stipes 60—75μ. Spores oval-elliptic, gibbous or navicular, medium to chestnut brown, 3·0—7·5 × 6·0—15·0μ, ave. 4·5 × 9·4μ.

Material examined:

Perfect Stage: Davidson in FPF 252; on *Fagus grandifolia*, Kirkland, N. B., Canada. Farlow; Newton, Mass., U.S.A., (1893), (AA). Kanouse; on *Betula*, Quincy, Michigan, U.S.A., (1929) (AA). Kauffmann; on *Fagus*, Elkmont, Tenn., U.S.A., (1916), (AA). Kauffmann; on *Acer* sp. Seventh Lake, Adirondack mtns, New York State, U.S.A., (1921), (AA). Martin 624; ex Barnett & Stipes, Morgantown, West Virginia, U.S.A., (1962). Martin 1,600, 1,601, 1,603 (+*Graphium* imperfect stage); Stoneybrook, Rockland Co., N.Y. State, U.S.A., (1963). Martin 1,719, 1,723; Savoy State forest, Mass., U.S.A., (1963). Martin 1,744; Wine Hill, Oneonta township, Otsego Co., N.Y. State U.S.A., (1963). Martin 1,763; ex Carroll 112, Briar-Patch farm, Austin, Texas, U.S.A., (1960). Martin 1,766; ex Carroll 120, Vulcan Irazu, Costa Rica, (1962). Miller; on *Fagus grandifolia*, Princeton, Ga., U.S.A., (1928), (AA). Schweinitz 1,204; Bethlehem, Pocono, P.; U.S.A., (NYBG).

Imperfect Stage:

sub *Isaria virginiensis* E. &. E. Nuttall 102; Nuttallburg, W. Va., U.S.A., (1893), (NYBG).

Cultural Characters: (Plate III: 7):

Colonies velvet felty, thinly growing with coarse texture, uniform dull white. Margin entire, not distinct, with the peripheral hyphae lying together. Conidia develop by 7 days but are not conspicuous. Stain red-orange to roseate, dispersed. Growth at 25°C moderate, 3—4 mm./day.

Microscopic Characters: (Fig. II: 4):

Primary mycelium undiagnostic; maximum diameter of marginal hyphae = 2·3μ. Secondary mycelium loosely organized to ropy, 3·1—4·3μ diameter.

Imperfect Stage: (Fig. II: 3, Plate V: 5—6). See also Martin (1967), Plate IV: 5. Brefeld O. Untersuchungen aus dem Gesammtgebiete der Mykologie X, Ascomyceten **2**, 260, (1891). Jaczewski A. L., Bull. Soc. Myc. de France **2**, 123, (1895).

The coremial stage mentioned in the literature has been so far only observed in association with developing stromata and not in culture. Fresh material collected in New York showed that the *Graphium*-type coremia arose from the base of the stromata as in *H. fragiforme* but not forming a distinct circlet, and were decumbent to erect, sometimes rather twisted, measuring 0·1—0·2 × 1·7—3·7 mm., unbranched, dull brown, and fertile over the apices only.

Conidiophores developed on coremia and in culture are identical, 165—430μ long, dichotomously branched to the first degree over the upper half of the primary axes; axes 1·5μ diam. The fertile branches are smooth with unspecialized heads, 21—37 × 1·2—1·8μ. The conidia are pleuracrogenous or acrogenous, borne on slender sterigmata, oval or clavate with narrow truncate bases, ochraceous, 1·8—2·5 × 3·7—4·3μ, ave. 2·3 × 4·2μ.

4. **Hypoxylon multiforme** Fries. Plate V: 1 & 3.

Berkeley, M. J. in Smith J. E., English Flora **5,** (2), 237, (1836); Hooker's Journ. of Bot. **6,** 226, (1854); Grevillea **4,** 49, (1875); Journ. Linn. Soc. **14,** 351, (1875). Berlèse A. N. & G. Bresadola, Ann. Soc. Alp. Trid. **14,** 21, (1887—1888). Bizzozero G., Flora. Ven critt. **1,** 200, (1885). Cooke M. C., Handbook of British Fungi **2,** 794, (1871); Ann. N.Y. Acad Sci. **1,** 184, (1871); Handbook of Australian fungi 294, (1892). Dennis R. W. G., British Cup Fungi 177, (1960). Durieu de Maisonneuve M. & J. F. C. Montagne, Explor. Alger **1,** 452, (1846). Fries E. M., Summa Veg. Scand. 384, (1849). Fuckel L., Symbolae mycologicae 234, (1869—1870); Ibid, Nachtrag **1,** 37, (1871). Hennings P., Hedwigia **42,** 82, (1903). Karsten P. A., Myc. Fenn. 2, Pyrenomycetes: 41, (1873). Kickx J., Flora Crypt. Flandres 308, (1867). Lambotte E., Flora Myc. belge 442, (1880). Lloyd C. G., Myc. Writ. **7,** 1,312, (1924); Ibid **7,** 1,364, (1925). Miller J. H., Journ. Dept. Agric Puerto Rico **14,** 272, (1930); Trans. Brit. Mycol. Soc. **15,** 139, (1930); World Species of *Hypoxylon* 48, (1961). Nitschke T., Pyren. Germ. **1,** 43, (1867). Owens C. E., Proc. Indiana Acad Sci. **1911,** 303, (1912). Rabenhorst G. L., Deutsch. Kryptflor. I, 221, (1844); Kryptflor. Deutsch. III, 857, (1887). Saccardo P. A., Nuovo Giorn. Bot. Ital. **8,** 184, (1876); Syll. Fung. I, 391, (1882); Fungi Ital. 573, (1877—1886). Shear C. L., Mycologia **20,** 85, (1928). Starback K., Bih. Svenska Vet-akad. Handl. **15,** 8, (1889); Ibid **27,** (9), 9, (1901). Sydow H. & F. Petrak, Ann. Myc. **20,** 184, (1922).

sub *Hypoxylon atropurpureum* (Pers.) Fries. Cook M. C., Handbook of British Fungi **2,** 796, (1871). Currey F., Trans. Linn. Soc. Lond. **22,** 267, (1859). Ellis, J. B. & B. M. Everhart, Journ. Mycol. **4,** 87, (1888); North Amer. Pyren. 647, (1892). Fries E. M., Summa Veg. Scand. 384, (1849). Jaczewski A. L., Bull. Soc. Myc. de France **2,** 117, (1895). Nitschke T., Pyren. Germ. **1,** 48, (1867). Owens C. E., Proc. Indiana Acad. Sci. **1911,** 300, (1912). Rabenhorst G. L., Kryptflor. Deutsch. II, 854, (1887). Saccardo P. A., Nuovo Giorn. Bot. Ital. **8,** 183, (1876); Fungi Ital. 577, (1877—1886). Traverso J. B., Flora Ital. Crypt. **1,** 53, (1906).

sub *Hypoxylon corrugatum* (Fr.) Cke. Cooke M. C., Grevillea **2,** 129, (1883).

sub *Hypoxylon crustaceum* (Sow.) Nits. Bresadola G. & P. A. Saccardo, Malpighia **2**, 294, (1897). Ellis, J. B. & B. M. Everhart, Journ. Mycol. **4,** 91, (1888); North Amer. Pyren. 652, (1892). Jaczewski A. L., Bull. Soc. Myc. de France **2**, 118, (1895). Nitschke T., Pyr. Germ. **1,** 49, (1867). Rabenhorst G. L., Kryptflor. Deutsch. **2,** 853, (1887). Spegazzini C., Anal. Soc. Cient. Arg. **18,** 270, (1884). Traverso J. B., Flora Ital. Crypt. **1,** 53, (1906).

sub *Hypoxylon granulosum* Bull. ex Fr. Bulliard P., Hist. Champ. de Fr. **1,** 176, (1791). Fries E. M., Summa Veg. Scand. 384, (1849). Quélet L., Champ. Jura & Vosges **3,** 491, (1875). Rehm H., Leafl. Philipp. Bot. **8,** 2,958, (1916). Schröter J. in Cohn, Kryptflor Schlesien 460, (1908). Traverso J. B., Flora Ital. Crypt. **1,** 48, (1906).

sub *Hypoxylon hookeri* Berk. ex Cooke. Cooke M. C., Grevillea **2,** 129, (1883).

sub *Hypoxylon transversum* (Schw.) Sacc. Saccardo P. A., Syll. Fung. **1,** 391, (1882).

sub *Peripherostroma granulosum* Gray. Gray S. F., Natural Arrangement of British Plants **1,** 514, (1821).

sub *Sphaeria atropurpurea* Pers. Fries E. M., Obs. Myc. 174, (1815); Syst. Myc. 340, (1823); Junghuhn F. H., Praemissa Fl. crypt. Javae 18, (1838). Persoon C. H., Syn. Meth. Fung. 18, (1801—1808). Rabenhorst G. L., Deutsch. Kryptflor. I, 219, (1844).

sub *Sphaeria crustacea* Sow. Sowerby J., English Fungi 1: tab 372, f 11., (1802).

sub *Sphaeria multiformis* Fr. Fries E. M., Obs. Myc. 169, (1815); Syst. Myc. 334, (1823); Elenchus fung. **2,** 64, (1828). Sommerfelt S. C., Supp. Flora Lapp. 205, (1826).

sub *Sphaeria peltata* DC. De Candolle A., Flor. Fr. **2,** 287, (1805).

sub *Sphaeria rubiformis* Pers. Persoon C. H., Syn. Meth. Fung. 9, (1801—1808).

sub *Stromatosphaeria elliptica* Grev. Greville R. K., Flora edinensis 357, (1824).

Stromata pulvinate to aplanopulvinate, or aplanate, superficial or erumpent through bark, sometimes linear when protruding through lenticels, as of *Betula*, 2·0—15 × 3·2—84 × 1·1—5·0 mms. Initial stage typically yellow-brown, deepening to dull brown and finally black; purple stromata not seen. Acetone extract of stroma deep brown. Surface of stroma smooth or somehwat granulate, usually convex but flat to concave in lenticular forms; ectostroma corky, entostroma hard externally and corky within. Perithecia completely or partially evident in outline, rarely entirely immersed, globose, 600—1,000μ; stipes 60—117μ. Spores oval elliptic, equilateral, gibbous, navicular or crescentric, amber to pale brown, 3·0—6·5 × 7·5—14·5μ; ave. 4·2 × 9·5μ.

Material examined: A wide range of material in the Ann. Arbor, Helsinki, NFC and NYBG herbaria. Martin 679; culture ex Centraalbureau, Baarn, Holland, (1961). Martin 695, 703, 707; Klamath; Northern California, U.S.A. (1961). Martin 769—771, 784; O'Brien, Northern California, U.S.A., (1961). Martin 793, 797—799, 805, 813, 820, 822, 823, 832—837, 884, 845, 856, 857—860, 862, 876; Arcata, Northern California, U.S.A., (1961). Martin 1,147; Lake Ozark, Mo., U.S.A., (1962). Martin 1,596; Stoneybrook, Rockland Co., N.Y. State, U.S.A., (1963). Martin 1,696; Conway State forest, Mass., U.S.A. (1963). Martin 1,726, 1,731; Savoy State forest, Mass., U.S.A. (1963). Martin 1,807; ex Carroll 119, Vulcan Irazu, Costa Rica, (1963). Martin 1,836; Vancouver, B.C., Canada, (1965).

Cultural Characters: (See Martin (1967). Plate II: 2):

Colonies felty, with thin coarse texture, uniform, dull white. Margin not distinct, with peripheral hyphae lying together. Conidia absent or sparsely produced when old. Stain dull buff brown. Growth fast, 6·2—7·5 mm./day at 25°C.

Microscopic Characters:

Primary mycelium undiagnostic; marginal hyphae with a maximum diameter of 2·5μ. Secondary mycelium loosely organized, 3·0—8·3μ diam.

Imperfect Stage (Fig. II: 1—2, Plate V: 7):

Brefeld O. Untersuchungen aus dem Gesamtgebiete der Mykologie X, Ascomyceten **2,** 260, (1891). Jaczewski A. L., Bull. Soc. Myc. de France **2,** 122, (1895).

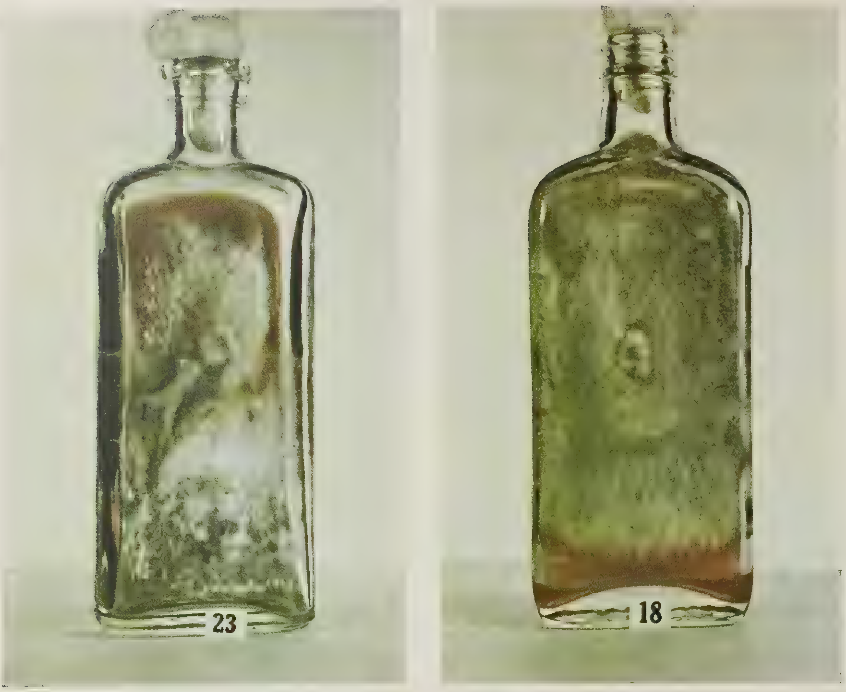
Coremia unknown in the field or in culture. Conidiophores short, 42—120μ long, axes 1·5—1·8μ diam., unbranched or branched dichotomously or ternately to the first degree over the upper half of the main axes; some fertile branches in trident formation; fertile branches 12—67 × 1·5—1·8μ, smooth, with unspecialized or slightly swollen heads. Conidia acrogenous, on slender sterigmata, elliptic-pyriform, yellow, 1·8—2·5 × 5·6—8·1μ, ave. 2·3 × 7·1μ.

II. Section Annulata.

5. **Hypoxylon truncatum** (Schw. ex Fr.) Miller. Plate I: 3—6.

Chardon C. E., Bull. Soc. Venez. Cien. Nat. **40,** 31, (1939); *et al.* Mycologia **32,** 182, (1940). Miller J. H., Trans. Brit. Mycol. Soc. **17,** 130, (1932); Bothalia **4,** 254, (1942); Miller J. H., World Species of *Hypoxylon* 95, (1961).

sub *Hypoxylon annulatum* (Schw.) Mont. Chardon C. E., Mycologia **13,** 295, (1922). Cooke, M. C., Ann. N.Y. Acad. Sci. **1,** 184, (1878); Handbook of



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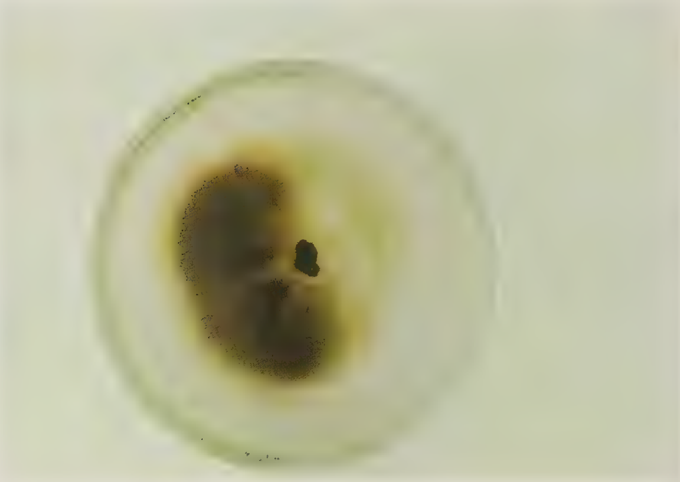

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PLATE II. Colouration.

1. *Hypoxylon truncatum;* bottle cultures 2 weeks old at 25°C. 2. *H. stygium;* reverse of plate culture to show stain.

Australian Fungi 294, (1892). Currey F., Trans. Linn. Soc. Lond. **22,** 264, (1859). Ellis J. B., Proc. Acad. Nat. Sci. Philad. III, **25,** 27, (1895). Ellis, J. B. & B. M. Everhart, Journ. Mycol. **4,** 68, (1887); North Amer. Pyren. 640, (1892). Hennings P., Hedwigia **47,** 259, (1908). Lloyd C. G., Myc. Writ. **7,** 1,352, (1925). Miller J. H., Mycologia **20,** 317, (1928). Montagne J. F. C. in Gay: Hist. Chile **7,** 445, (1850). Owens C. E., Proc. Indiana Acad. Sci. **1,911,** 307, (1912). Rehm H., Hedwigia **21,** 136, (1882); Leafl. Philipp. Bot. **8,** 2,957, (1916). Rick J., Broteria Bot. Ser. **25,** 22, (1931). Shear C. L., Lloydia **8,** 249, (1945). Starback K., Bih. Svenska ver-akad. Handl. **27,** (9), 7, (1901); Arkiv fur Bot. **5,** 30, 1905. Theissen F., Ann. Mycol. **6,** 536—538, (1908); Ibid **7,** 155, (1909). Viègas A. P., Bragantia **4,** 101, (1944). Welwitsch F. & F. Currey, Journ. Linn. Soc. **26,** 283, (1868).

sub *Hypoxylon chalybeum* Berk. & Br. Berkeley M. J. & C. E. Broome, Journ. Linn. Soc. **14,** 121, (1873). Cesati V., Atti. R. Accad. Sci. Fis. e. Matem. **8,** 17, (1879). Petch T., Ann. Roy. bot. gard. Perad. **8,** 151, (1924).

sub *Hypoxylon apiahynum* Speg. Spegazzini C., Bol. Acad. Nac. Cienc. Cordoba **11,** 506, (1889).

sub *Hypoxylon circumscribum* Lloyd. Lloyd C. G., Myc. Writ. **7,** 1,312, (1924).

sub *Hypoxylon glomiforme* Berk. & Curt. Berkeley M. J. Grevillea **4,** 49, (1875). Ellis J. B. & B. M. Everhart, Journ. Mycol. **4,** 43, (1888); North Amer. Pyren. 635, (1892). Shear C. L., Lloydia **8,** 262, (1945).

sub *Hypoxylon leptascum* Speg. Spegazzini C., Bol. Acad. Nac. Cienc. Cordoba **11,** 507, (1889).

sub *Hypoxylon moriforme* Henn. Hennings P., Engl. Jahrb. **23,** 287, (1896).

sub *Hypoxylon murraii* Berk. & Curt. Berkeley, M. J., Grevillea **4,** 49, (1875).

sub *Hypoxylon piptadeniae* Henn. Hennings P., Hedwigia **48,** 11, (1909).

sub *Hypoxylon subeffusum* Speg. Rehm H., Leafl. Philipp. Bot. **8,** 2,958, (1916). Spegazzini C., Anal. Soc. Cient. Arg. **18,** 274—275, (1884); Anal. Soc. Cient. Arg. **26,** 32, (1888). Theissen F., Ann. Mycol. **7,** 157, (1909).

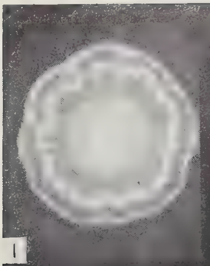
sub *Hypoxylon vernicosum* Ell. & Ev. Ellis J. B. & B. M. Everhart, Amer. Nat. **31,** 426, (1897).

sub *Sphaeria annulata* Schw. Fries F. M., Elenchus fungorum II, 64, (1828); Schweinitz L., Journ. Acad. Nat. Sci. Philad. **5,** 11, (1825).

sub *Sphaeria truncata* Schw. Fries E. M., Syst. Myc. II, 442, (1823). Schweinitz L., Syn. Fung. Car. Sup. 44, (1822).

sub *Sphaeria truncatula* Schw. Schweinitz L., Syn., Fung. Car. Sup. 210, (1822).

Stromata variable in appearance, pulvinate to aplanopulvinate, 0·9—31 × 0·9—111 × 0·9—2·0 mms., on bark or decorticated wood. Initial layer yellow to yellow-green, often persistent at maturity as a sterile olivaceous mat encircling the developed stroma; ectostroma crustose, rather thin, with yellow green par-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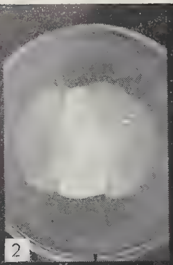
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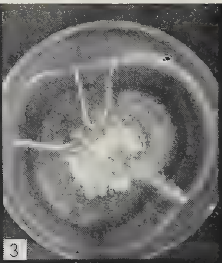
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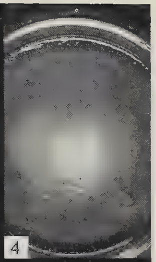
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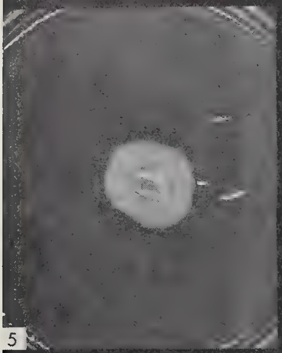
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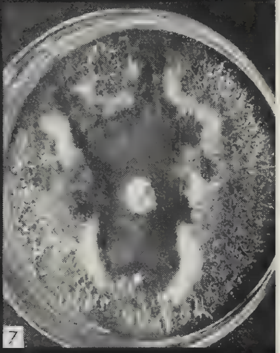
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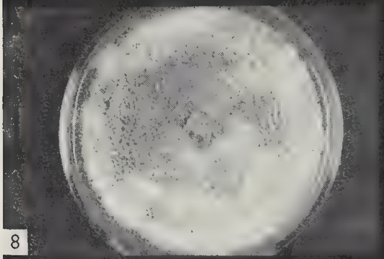
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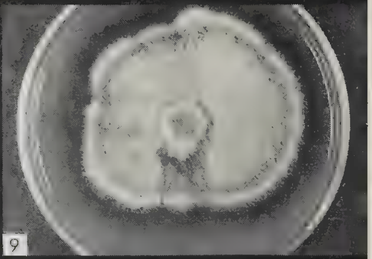
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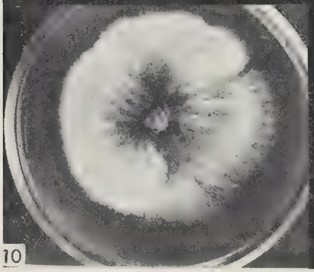
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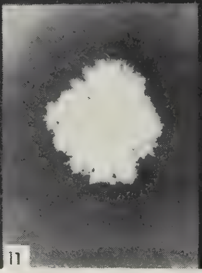
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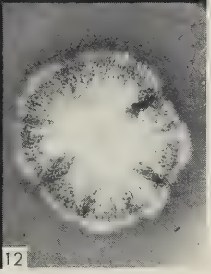
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ticles seen on microscopic examination and yielding an acetone extract of similar colour. Entostroma usually massive, carbonaceous, deep black. Perithecia completely evident to completely immersed, oval or globose, 800—1,200 × 800—1,700μ; ostioles medium papillate surrounded by truncate discs 0·4—0·7 mm. diam. Asci cylindric, 97—170 × 4—6μ. Spores oval to elliptic, equilateral, gibbous or navicular, amber to medium brown, 3·0—6·0 × 6·0—11·5μ; ave. 41 × 8·9μ. The writer considers that *Hypoxylon marginatum*, which has hemispherical stromata, may possibly be a distinct species. Miller regards it as identical with *H. truncatum*.

South African hosts: These probably comprise a very wide range and include *Cassine croceum*, *Maytenus buxifolia*, *Olea capensis*, *Royena lucida*, *Trichocladus crinitus*.

Material examined: A wide range of material in the Ann. Arbor, CMI, NFC and NYBG herbaria.

Martin 13, 29, 44, 71, 80, 89, 146, 311, 342, 370, 401, 450, 452, 458, 471—473, 475, 477, 486, 1,011, 1,046, 1,047, 1,186; Nature's Valley, Knysna District, Western Cape, South Africa, (1958, 1959, 1962). Martin 224; Hogsback, Alice District, Eastern Cape, South Africa, (1958). Martin 387; Alexandria Forest, Alexandria District, Eastern Cape, South Africa, (1958). Martin 640; Baton Rouge, La., U.S.A., (1961). Martin 939; Mazatlàn, Sinaloa, Mexico, (1961). Martin 1,106; Columbia, Mo., U.S.A., (1962). Martin 1,133—1,135, 1,141, 1,180; Lake Ozark, Mo., U.S.A., (1962). Martin 1,520, 1,551; San Blàs, Mexico, (1962). Martin 1,770 ex Carroll 130; Vulcan Irazu, Costa Rica, (1962).

Cultural Characters: (Plate II: 1, Plate III: 9, Plate IV: 2):

Colonies felty, dense to somewhat sparse. forming an aerial mat of mycelium up to 2 mms. high; surface sometimes smooth but characteristically coarse and often straggling. The colour is white at first, pale yellow by 10 days, then tawny or discoloured, finally dull brown to grey with age. Margin distinct from the rest of the colony, 5—15 mm. broad submersed to canescent, white subhyaline

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PLATE III. Plate Cultures.

All colonies 2 weeks old at 25°C except where stated.

Hypoxylon investiens. 1. Malt agar. 2. Leonian's agar, showing fine surface. 3. Colony as in (2), 3 weeks old with coarser surface and brown stain in age. 4. Czapek's agar. *H. rubigineo-areolatum.* 5. Leonian's agar, 4 weeks old. (Malt similar). 6. Maize agar in bottle culture, 4 weeks old. 7. *H. cohaerens;* malt agar. 8. *H. stygium;* malt agar. 9. *H. truncatum;* malt agar. 10. *H. stygium;* Czapek agar. 11–12. *H. denudatum;* Czapek and malt agar respectively.

to colourless, entire with effuse or parallel peripheral hyphae. Conidia are sparsely produced in the centre of the colony, yellow, inconspicuous. Stain deep yellow ochre, tawny, feuille morte or ochre brown at the centre of the colony, lighter outside, and extending beyond the margin in some cultures. Growth on other media broadly similar, but pearly white on maize, and denser on Czapek with roseate or red-ochre stain. Rate of growth moderate to fast, 2·8—5·0 mm./day at 25°C.

Microscopic Characters (Fig. III: 7—9):

Primary mycelium without distinguishing character; marginal hyphae with a maximum diameter of 6·0μ. Secondary mycelium uniform, rather frequently branched but loosely organized, 2·5—4·6μ diam. In one strain dark carbonaceous bodies were observed to develop from small apical or intercalary segments of the hyphae. Segments increased to a maximum diameter of 22μ and became black and carbonized as in *H. entoleucum* (Martin, 1968).

Imperfect Stage. (Plate V: 8—10, Fig. III: 10):

sub *Hypoxylon annulatum* (Schw.) Mont. Ellis J. B. & B. M. Everhart N. Amer. Pyren. 640, (1892).

sub *Verticillium puniceum* Cke. & Ellis. Cooke M. C. Grevillea **17,** 69, (1889).

Conidiophores usually sharply distinct from the vegetative mycelium due to their amber or yellow colouration, pitted walls and determinate growth, 100—690μ long, axes 1·8—3·7μ in diameter; branched dichotomously, ternately or quadrately to the second degree or indefinitely over the upper halves or in the apical regions of the primary axes. Fertile branches unspecialized, 10—36 × 1·5—3·1μ, very occasionally 1—septate, and sometimes rather narrow and attenuated. Conidia borne in apical clusters of 3—8 or sporadically off the sides of the fertile branches, variable in form, usually oval-elliptic or pyriform but occasionally sausage-shaped, equilateral, arising from slender sterigmata, yellow-green collectively, 1·2—2·9 × 3·7—9·7μ, ave. 1·8 × 4·8μ.

6. **Hypoxylon stygium** (Lév.) Sacc. (Plate I: 7, Plate V: 2 & 4.)
Miller J. H., Trans. Brit. Mycol. Soc. 17, 129, (1932); Monog. Univ. Puerto Rico B 2, 207, (1934); Bothalia **4,** 253, (1942); World Species of *Hypoxylon* 91, (1961). Saccardo P. A., Syll. Fung. I, 379, (1882).

sub *Hypoxylon annuliforme* Rehm. Hennings P., Bot., Jahrb. **14,** 366, (1892). Rehm H., Verh. Bot. ver Prov. Brandenburg **31,** 65, (1890).

sub *Hypoxylon borgoriense* v. Hohn. von Hohnel F., Sitz. k. Akad. d. Wiss. Wien. **118,** 341, (1909). Rehm H., Ann. Mycol. **7,** 404, (1909).

sub *Hypoxylon microcarpum* Penz. and Sacc. Penzig O. & P. A. Saccardo., Malpighia II, 492, (1897); Icon. Fung. Jav. 26, (1904). Theissen F., Ann. Mycol. **6,** 536, (1908).

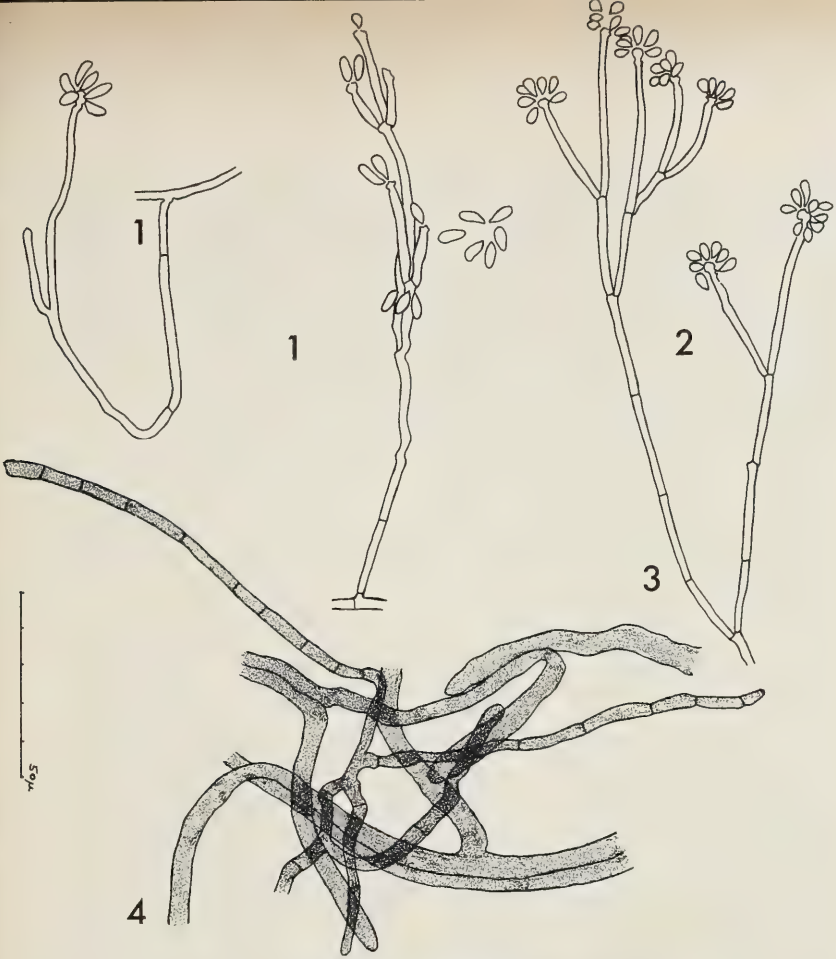

FIG. II. Microscopic characters.
-2. *Hypoxylon multiforme*, conidiophores and conidia. *H. cohaerens*. 3. Conidiophore. 4. Secondary mycelium.

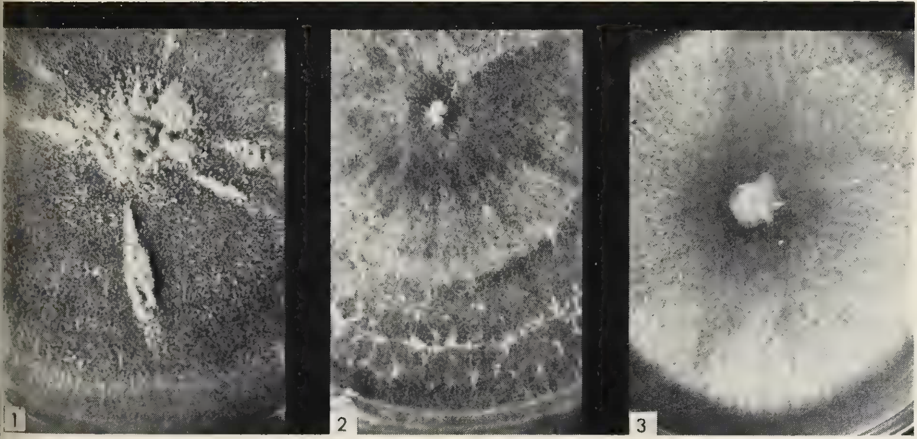

PLATE IV. Close-up of Colony surfaces on malt, 2 weeks at 25°C.
1. *Hypoxylon investiens*. 2. *H. truncatum*. 3. *H. stygium*.

sub *Hypoxylon platystomum* E. & E. Ellis J. B. & B. M. Everhart, N. Amer. Pyren. 649, (1892).

sub *Hypoxylon puiggarii* Speg. Spegazzini C., Bol. Acad. Nac. Cienc. Corboda II, 508, (1889).

sub *Nummularia annulata* Rehm. Rehm H., Ann. Mycol. **11,** 399, (1913).

sub *Nummularia stygia* (Lév.) Lloyd. Lloyd C. G., Myc. Writ. **7,** 1,312, (1924).

sub *Sphaeria platystoma* Fries. Fries E. M., Systema Mycologicum 351, (1823).

sub *Sphaeria stygia* Lév. Léveillé M. J. H., Ann. Sci. Nat. Bot. III, **5,** 258, (1846).

Stromata aplanate crustose, usually on the surface of decorticated wood, 2·8—28 × 12·8—114 × 0·4—2·0 mms. Initial stage dull olive green, sometimes with a red or purplish tint. Acetone extract of stroma olive green. Ectostroma shining black at maturity, rather thin with a smooth surface; entostroma partly carbonaceous but not as massive as in *H. truncatum.* Perithecia evident at vertices to completely immersed, globose or ovate, 500—800 × 750—900μ; ostioles medium papillate surrounded by small truncate discs 0·2—0·3 mms. diameter. Asci cylindric, with stipes of variable length, 54—170 × 3—5μ; stipes 9—105μ. Spores oval equilateral, amber, subhyaline, 2·0—5·0 × 4·5—8·5μ, ave 2·9 × 6·3μ.

South African hosts: Acacia mollissima, Olea capensis.

Material examined:

sub *Hypoxylon bogoriense*, von Hohnel in Rehm 1844; on *Albizzia moluccana*, Buitenzorg, Java, (1908), (AA), (NYBG).

sub *Hypoxylon cinnabarinum* Rick; Brazil, (1905), (AA).

sub *Hypoxylon marginatum* Rick; Brazil, (1907), (AA).

sub *Hypoxylon platystomum* Kauffmann; Brooksville, Fla., U.S.A., (1918), (AA). Kauffmann; Brooksville, Fla., U.S.A., (1919), (AA). Langlois 2,333; on *Melia*, St. Martinsville, La., U.S.A., (1890), (NYBG).

sub *Hypoxylon polyspermum* Calkins in Ellis & Everhart's N. Amer. Fungi 1788; Florida, U.S.A., (1886), (AA). Kauffmann; on *Carpinus*, Little River, Fla., U.S.A., (1919), (AA).

sub *Hypoxylon sanguinosum* Rick; Brazil, (1932), (AA).

sub *Hypoxylon stygium* Martin 234; Hogsback, nr. Alice, Eastern Cape, South Africa, (1958). Martin 968, 1,509, 1,519, 1,521, 1,548, 1,552; San Blàs,

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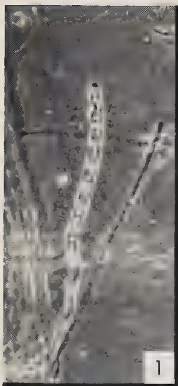
PLATE V.

1–4. Asci and spores. 1 & 2. *Hypoxylon multiforme* and *H. stygium.* X 290. 3 & 4. Same, showing detail of spores and ascal plugs. X 720. 5–6. *H. cohaerens*, coremia developed in culture. 5. X 110. 6. X 290. 7. *H. multiforme*, smooth conidiophore. X 720. 8–10. *H. truncatum*, warted conidiophores. 8. Bright field. X 720. Note colouration in main axes. 9. The same, phase contrast. 10. Smaller conidiophore, branching pronouncedly verticillate.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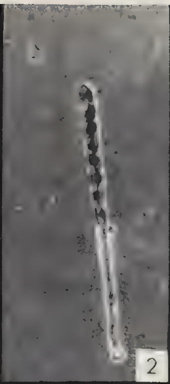
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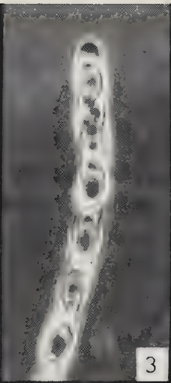
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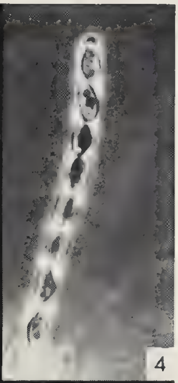
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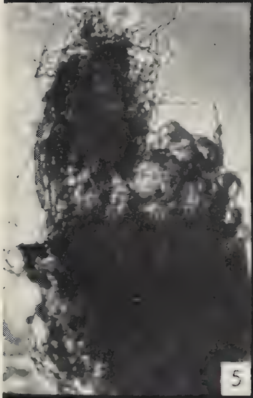
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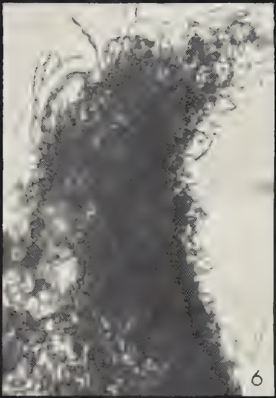
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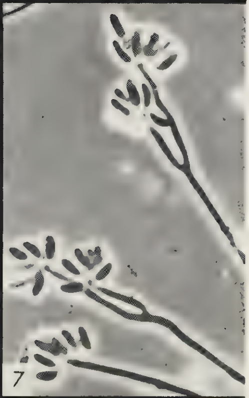
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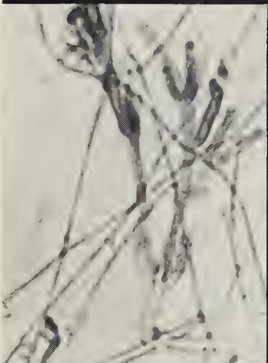
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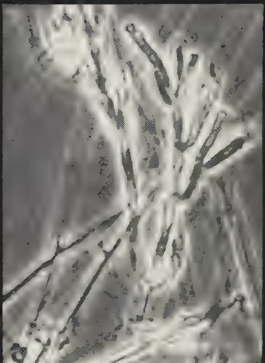
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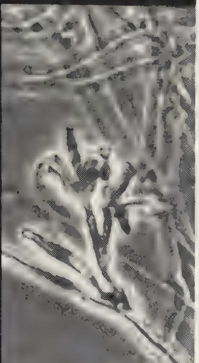
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Nayarit, Mexico, (1961, 1962). Martin 1,017; Nature's Valley, Knysna District, Western Cape, South Africa, (1962). Martin 1,075, 1,076; Hawaii, (1962). Martin 1,768, 1,769; ex Carroll 125, 127, Puerto Vieho, Costa Rica, (1963). Parks 22,371; Rarotonga, Maungatoa mtn., Hawaii, (AA), (1929). Theissen in Rehm's Ascomyceten 2,086; Sao Paulo, Brazil, (AA.)
sub *Nummularia rufa* E. & E. Smith 54; Nicaragua, (1893), (NYBG).

Cultural Characters: (Plate II: 2, Plate III: 8 & 10, Plate IV: 3):

Colonies felty, with a moderately coarse to smooth surface, and aerial mycelium up to 2 mms. high; dull white usually tinted cream or greenish by 2 weeks and becoming grey with age. In one bottle culture the colours were restricted to zones of the aerial mycelium so that there was alternation between shades of yellow and yellow-grey. Margin usually distinct depending on the degree of development of the aerial mycelium; up to 5 mm. broad, canescent to submersed, colourless, entire, with peripheral hyphae widely dispersed. Conidia pale yellow-green to fawn, formed sparsely or in small pulvinate groups over most of the colony, appearing by 7—10 days or with age. Stain amber to chestnut brown, sometimes olive green, diffuse in bottle culture but in plates characteristically appearing as a broad ring just behind the margin of the colony and then spreading inwards to the centre. Growth on other media besides malt is broadly similar but colours tend to be more intense and guttation of stain as blood red drops may occur on maize agar and on Czapek agar. Growth rate on malt agar fast, 5·0—6·5 mm./day.

Microscopic Characters:

Primary mycelium undiagnostic; marginal hyphae broad, up to $3 \cdot 7\mu$ diam. Secondary mycelium loosely anastomosed, frequently branched, hyphae $1 \cdot 5$—$6 \cdot 0\mu$ diam.

Conidiophores and conidia (Fig. III: 12):

The conidiophores are clearly distinct from the vegetative mycelium by the slightly greater width of hyphae, fine wall pitting and deep amber to yellow colour. They are 90—250μ long with axes $1 \cdot 8$—$4 \cdot 0\mu$ diameter, and are branched to the first or second degree dichotomously, ternately or quadrately over the upper halves or terminal portions of the main axes only. Fertile branches usually

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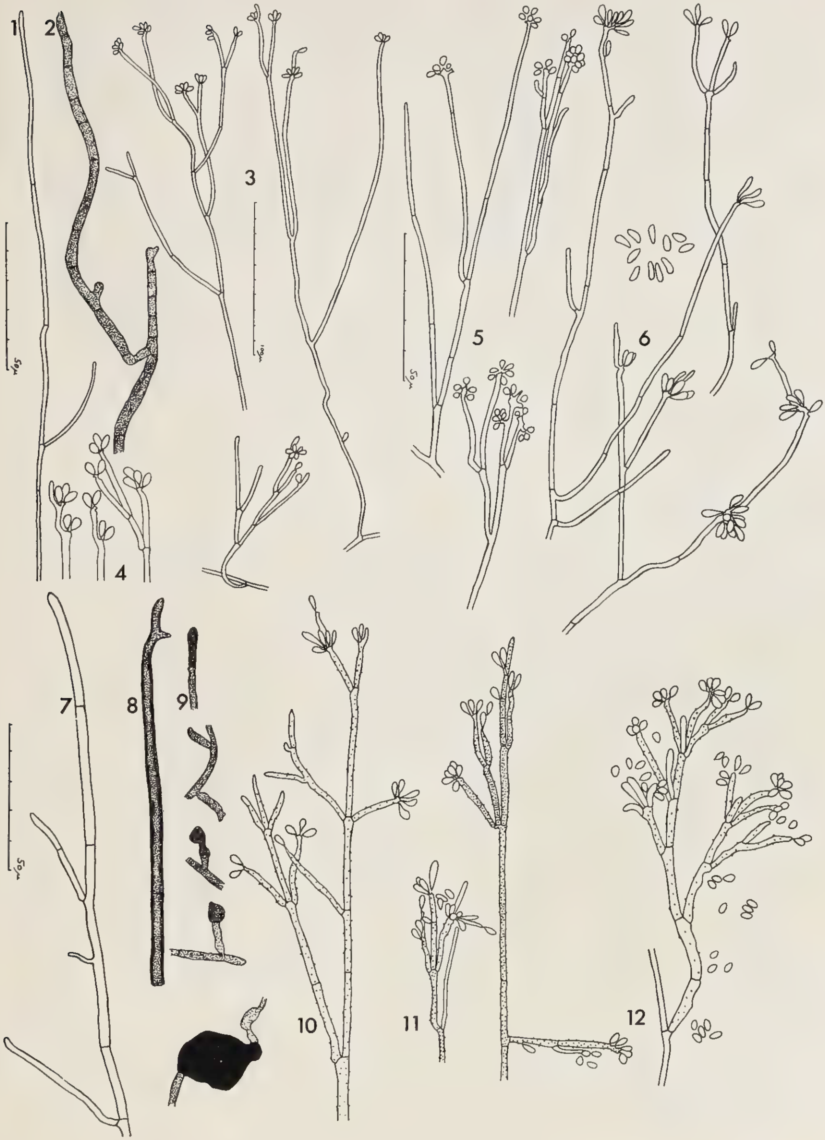
Fig. III. Microscopic Characters.

1–5. *Hypoxylon investiens*. 1. Marginal hypha. 2. Secondary mycelium. 3. Whole conidiophores, to small scale (strain 212). 4. Apices of conidiophores, enlarged (strain 212). 5. Smaller conidiophores of strain 389; same scale as in (4). 6. *H. rubigineo-areolatum;* conidiophores and spores. 7–10. *H. truncatum*. 7. Marginal hypha. 8. Secondary mycelium. 9. Development of carbonous bodies, cf. *H. entoleucum* (Martin, 1968). 10. Conidiophore. 11. *H. denudatum* conidiophore. 12. *H. stygium* conidiophore.


50μ
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in trident formation, smooth, sometimes with globose apices, 9—30 × 1·4—3·0μ. Conidia acrogenous, in clusters of 6—12; oval, equilateral or pyriform, borne on slender sterigmata, yellow or yellow-green collectively, turning to fawn, 2·0—2·6 × 3·1—5·6μ; ave. 2·2 × 4·2μ.

7. **Hypoxylon denudatum** Petch. Plate I: 8, Fig. I: 2.

Petch T. Ann. roy. bot. gard. Perad. **8,** 154, 1924.

Stromata aplanate or pulvinate, normally multiperitheciate but also comprising forms where the perithecia are single or loosely aggregated; 0·6—5·7 × 0·6—8·0 × 1·2—1·7 mms. The colour of the young and early mature stroma varies from brick red to metallic purple. Acetone extract russet-purple. Ectostroma slight; entostroma usually fairly well developed, externally carbonaceous. Perithecia evident to base or only vaguely in outline, globose to oval variable in size, 550—1,000 × 550—1,300μ; ostioles medium papillate, encircled by truncate discs 0·3—0·5 mm. diam. Asci cylindric, 120—180 × 4—5μ; stipes 50—90μ. Spores oval-elliptic, light brown, subhyaline, 3·0—7·0 × 7·0—12·5μ; ave. 4·5 × 9·4μ.

South African Hosts: Olea capensis.

Material examined: Martin 511, 556; Nature's Valley, Knysna District, Western Cape, South Africa, (1958, 1959). Martin 563; Mt. Misery, nr. Grahamstown, E. Cape, South Africa, (1960).

Cultural Characters (Plate III: 11—12):

Colonies at first appressed felty, later characteristically becoming denser with coarse cottony surface. Aerial mycelium up to 3 mm. high, white subhyaline near the margin but variable in colour toward the centre, normally cream to primrose yellow at first, later tinted dull green and after a month murky grey. Margin usually distinct, up to 12 mms. broad entire, effuse. Conidia produced early in some cultures, late in others, granulate to smooth, dense, pale purplish brown to mousegrey. Stain variable usually produced in less than a week, extending to but not beyond the margin where it shows up behind the mycelium; roseate brown or warm sepia deepening to chestnut and finally dull black, rarely however olive green. Cultures on other media similar, those on Czapek more brilliant in hue and guttating drops of dark brown stain.

Microscopic Characters:

Primary mycelium undiagnostic, marginal hyphae with a maximum diameter of 2·9μ. Secondary mycelium loosely organized, closely branched, 1·9—3·6μ diam.

Conidiophores and conidia (Fig. III: II):

Conidiophores distinct from the vegetative mycelium in wider diameter, wall pitting, and vinaceous red tint. They are long, 270—350μ, branched dichotomously or ternately to the first degree over the terminal portion or upper halves of the main axes which are 2·1—2·3μ in diameter. Fertile branches 13—40 × 1·5—1·9μ, lying free or in trident position. Conidia acrogenous or occasionally produced either singly or in groups of 2 to 3 from the sides of the fertile branches, usually close to a septum. Conidia variable in form, usually oval-elliptic to pyriform but occasionally elongated and sausage shaped, equilateral or inequilateral, borne on slender sterigmata, 1·2—2·3 × 3·7—9·7μ; ave. 1·9 × 5·3μ.

The taxonomic position of this species and others in the annulate group with reddish stromata, such as *H. microcarpum* Penz. & Sacc. and *H. platystomum* E. & E., seems to be unresolved. Miller considers that they are all synonymous with *H. stygium;* the writer finds that while many samples of *H. stygium* have a red or purplish tint, a combination of deep purple colour in the stroma, red or purplish conidiophores and reddish brown stain in culture, further minor differences in cultural characters and a higher average ascospore size and darker colour of the ascospores should serve to classify other samples in a separate species. To date Petch's specific name seems to be the most appropriate.

8. **Hypoxylon thouarsianum** (Lév.) Lloyd.

Lloyd C. G., Myc. Writ. **6,** 102, (1919). Miller J. H., World Species of *Hypoxylon*, 87, (1961), (including var. *gilletianum*, Ibid p. 89).

sub *Hypoxylon amaniensis* P. Hennings. Hennings P., Bot. Jahrb. **38,** 115, (1907).

sub *Hypoxylon gilletianum* Sacc. Saccardo P. A., Ann. Mycol. **4,** 76, (1906).

sub *Hypoxylon malleolus* Berkeley. Berkeley M. J., Grevillea **4,** 49, (1875). Cooke, M. C., Ann. N.V. Acad. Sci. **1,** 184, (1878). Ellis, J. B. & B. M. Everhart, Journ. Mycol. **4,** 43, (1888); N. Amer. Pyren. 635, (1892). Lloyd C. G., Myc. Writ. **6,** 901, (1919).

sub *Hypoxylon occidentale* E. & E. Ellis J. B. & B. M. Everhart, Proc. Acad. Nat. Sci. Philad. III, **24,** 345, (1894).

sub *Sphaeria thouarsiana* Lév. Léveillé M. J. H., Ann. Sci. Nat. Bot. III, **5,** 258, (1846).

Stromata pulvinate to hemispheric, 4·0—40 × 4·0—51 × 2·2—22 mms., superficial on wood. Ectostroma slight; entostroma massive in development, carbonaceous to corky at the base, often showing traces of zonation in longitudinal section. Acetone extract olive green. Perithecia evident at vertices or immersed, oval, 600—900 × 800—1,100μ; ostioles medium papillate, discs 0·3—0·5 mm. diam. Asci not seen. Spores crescentic with acute or narrowly rounded ends, pale brown, 4·5—7·5 × 15·0—28·0μ; ave 5·8 × 20·0μ.

South African hosts: Olea capensis.

Material examined: Martin 30, 37, 40, 53, 90, 115, 125, 314, 346, 459, 1,013, 1,049, 1,190; Nature's Valley, Knysna District, Western Cape, South Africa, (1958, 1959, 1962). Martin 265, 266; Alexandria Forest, Eastern Cape, South Africa, (1958). Martin 615; Malibu Canyon, Los Angeles, California, U.S.A. (1961). Martin 689, 690; Stanford Botanical Reserve, Palo Alto, California, U.S.A., (1961). Martin 775; O'Brien, Northern California, U.S.A. (1961).

This species has not been cultured successfully despite repeated attempts. Olive green mycelium and disintegrated conidiophores similar to those of *H. truncatum* have been observed on parts of the stromata.

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